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STUDY OF VISUAL FATIGUE DUE TO EXTENDED GADGET USE DURING THE COVID-19 PANDEMIC

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ABSTRACT

Introduction Since the COVID-19 pandemic in Indonesia, many activities have been carried out online from home. This change in activity causes the frequency of gadget use to increase. Looking constantly at gadgets such as laptops, desktops, and mobile phones can risk visual problems or visual fatigue. **Aims:** this research is to describe visual fatigue and the factors that affect students due to the increasing use of gadgets. **Methods** This study is a quantitative study with a cross-sectional approach—collected data from April to June 2021. The sample in this study was 200 people. The variables are visual fatigue, viewing distance, eye breaks, and refractive error. Data were collected using a questionnaire distributed to respondents using google Forms. Data were analyzed by univariate and bivariate with 95% CI ($\alpha = 0.05$). **Result** The analysis showed that 87% of students experienced visual fatigue, 76% used gadgets at an unsafe distance, 92% did not rest their eyes, 39.5% had refractive errors. Statistical test results between visual fatigue with viewing distance (p-value = 0.53), eye breaks (p-value = 0.04) and refractive error (p-value = 0.44). There is a relationship between eye breaks and visual fatigue. Based on the results of this study, take eye breaks by applying 20-20-20, namely resting the eyes every 20 minutes by turning the eyes to see objects as far as 20 feet for 20 seconds when using gadgets to reduce the risk of visual fatigue.

Keywords: eye breaks, gadget, visual fatigue

INTRODUCTION

The Covid-19 pandemic in Indonesia since the beginning of 2020 has changed the order of people's lives in various aspects, one of which is the education aspect. The learning process becomes learning from home. By the Circular of the Minister of Education and Culture dated March 9, 2020, all educational institutions carry out learning from home. The distance learning system uses information and communication technology. Learning from home is done online using learning applications or social networks without having to face to face but through available platforms. All forms of learning materials gave with online, communication online and tests are also online. Carrying out online learning causes changes in student activities, namely, the frequency of using digital devices or gadgets increases.

Eyes that constantly look at digital devices such as laptops, desktops, and mobile phones can cause visual problems or visual fatigue with symptoms such as itchy, watery, dry eyes, sore eyes, blurred eyes, and even headaches (Shrestha, Mohamed and Shaha, 2011). Signs of visual fatigue are visual or eye disturbances due to various stresses associated with digital devices in the optical system, including eye pain, dryness, glare, and accommodation dysfunction (Coles-Brennan, Sulley and Young, 2019). Nearly 90% of people who spend three or more hours in front of a computer a day experience visual fatigue. It is estimated that nearly 60 million people experience visual fatigue from digital device use globally, and about 1 million new cases occur each year. The prevalence of computer users who experience visual fatigue ranges from 64-90%. For computer workers worldwide, about 70% report experiencing vision

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problems (Al Rashidi and Alhumaidan, 2017).

People at greatest risk of visual fatigue spend two or more hours continuously in front of a computer or using digital devices every day. Increasing the duration of using digital devices can increase the risk of experiencing dry eyes. The risk increases if the time spent using digital devices is more than 4 hours (Mufti et al., 2019). Symptoms of visual fatigue are discomfort that includes blurred vision, difficulty focusing vision, pain or throbbing around the eyes, double vision, difficulty focusing vision, watery eyes, red eyes, sore eyes, nausea, and headaches. The ciliary muscles and extraocular muscles are the leading cause of eye fatigue due to prolonged accommodation, especially during close vision activities. The severity level of eye fatigue depends on the lighting intensity, the type of activity, and the work environment conditions (Ananda and Dinata, 2015).

According to the Occupational Health and Safety Unit of the University of Queensland, the causes of eye fatigue are work equipment factors such as the monitor screen display and the size of the object on the screen, the environment in the form of lighting and room temperature, work design factors in the form of object characteristics, and work duration, and for individual characteristic factors such as disease history. Meanwhile, based on a survey conducted by the American Optometry Association, several factors can cause eye fatigue, namely refractive errors, lighting intensity, eye rest, and object shape and length of viewing of objects (AOA, 2002). In a study conducted on students at the Engineering College of Bengaluru, it was found that the prevalence of CVS was 86.67%, 79.3% of respondents spent more than three hours in front of the computer, and 82% did not take regular breaks. There was a relationship between the duration of using digital devices (p=<0.001) and taking frequent breaks (p=<0.001) with CVS complaints (Ranganatha and Jailkhani, 2019).

In a study conducted in Malaysia, the prevalence of CVS was 68.1%, there was a significant relationship between gender (p = <0.001), age (p = 0.005), use of glasses (p = 0.005), and duration of computer use (p = 0.051) with complaints of CVS. Respondents at risk for CVS are female respondents, have an age of fewer than 27 years, use glasses and use a computer for more than 7 hours a day (Rahman and Sanip, 2011). Increased use of digital devices can affect the tear film and ocular surface. This happens because during the use of digital devices, the frequency of blinking decreases, there is an increase in tear evaporation which can harm the condition of the eye surface (Artime Rios et al., 2019). Using a computer for more or equal to 7 hours every day continuously carries a risk of two times more likely to experience visual fatigue than those with a duration of less than seven hours (Valentina, 2018).

The COVID-19 pandemic has had an impact on the lecture process, including at Andalas University. By the Circular of the Minister of Education and Culture, the Chancellor of Andalas University issued a circular letter to help prevent the spread of COVID-19 by conducting online recovery. Online learning is carried out using various applications such as Zoom, Microsoft Teams, and ilearn, which can be accessed by lecturers and students using digital devices such as laptops, computers, and mobile phones. This change in activity causes the frequency of use of digital devices or gadgets to increase. Students must use gadgets in every learning method, such as presentations, individual assignments, group assignments, and final assignments. Therefore, the use of gadgets in students increases with online lectures and causes a high incidence of visual fatigue. Based on an initial study conducted on 30 students, as many as 22 students (73%) experienced complaints of visual fatigue. In general, 95% of students spend more than four hours using digital devices every day. As many as 65% of students do not take eye breaks

when using digital devices, and 20% of students use glasses to correct refractive errors. So, the purpose of this research is to describe visual fatigue and the factors that affect students due to the increasing use of gadgets

METHODS

This research is quantitative research with a cross-sectional approach. The study was conducted from April to June 2021. The sample in this study was 200 people. The variables are visual fatigue, viewing distance, eye breaks, and refractive error. Data were collected using a questionnaire distributed to respondents using google Forms. The instrument used to measure complaints of visual fatigue was measured using the CVSQ (computer vision syndrome questionnaire). Data were analyzed by univariate, and bivariate analysis using chi-square test with 95% CI ($\alpha = 0.05$). This study passed the ethical clearance and received ethical approval from the Research Ethics Commission, Faculty of Public Health, Andalas University with Certificate Number : 6/UN16.12/KEP-FKM/2021.

RESULT

Overview of Visual fatigue Complaints

Visual fatigue is measured by 15 questions about complaints experienced during and after using digital devices. The answer categories are never, sometimes and often or always, with the results being measured if the total score ≥ 6 is categorized as experiencing visual fatigue (Ríos et al., 2019).

Table 1. Frequency Distribution of Visual Fatigue Complaints

Visual Fatigue	n	%
Yes	174	87
No	26	13

From the study results, which can be seen in Table 1, it is known that 174 students (87%) experienced complaints of visual fatigue due to the increased intensity of using gadgets. Symptoms that are often experienced are watery eyes (30%), heavy eyelids (36.5%), and headaches (36.5%), can be seen in Table 2.

Table 2. Frequency Distribution of Complaints of Visual Fatigue

Symptoms	Percentage		
	Never	Sometimes	Often/ Always
The eyes feel hot	27.5	55.0	17.5
Eyes itch	30.5	51.5	18
Watery eyes	16	54	30
Eyes blink excessively	52	35.5	12.5
Rosy eyes	27.5	60	12.5
Pain in the eyes	31.5	44.5	24.0
Eyelids feel heavy	26	37.5	36.5
Eyes feel dry	31	43.5	25.5
Blurred vision	21	50.5	28.5
Double vision	62.5	28.5	9
Difficulty focusing when looking closely	57.5	30.5	12
Sensitive to light	32.5	45.0	22.5
Visible colored circles around the object being viewed	69.5	22.5	8
The view feels worse	42	37	21
Headache	10	53.5	36.5

Viewing Distance

The results of the study found that 152 students (76%) viewing distance with unsafe that can be seen in Table 2. Of the 200 students, when using the gadget is 150

people (75%) with a distance of less than 46 cm, 48 people (24%) between 41 - 61 cm, and two people (1%) with a length of more than 61 cm.

Table 3. Frequency Distribution of Viewing Distance when Using Gadgets

Viewing Distance	n	%
Unsafe	152	76
Safe	48	24

Eye Breaks

For the variable of eye breaks, it is said to do eye breaks when applying eye rest that is every 20 minutes by turning the eye to see objects as far as 20 feet for 20 seconds when using gadgets. From the results of the study, it is known that only 16 people (8%) did eye rest and 184 people (92%) do not rest their eyes while using gadgets.

Table 4. Frequency Distribution of Eye Breaks

Eye Breaks	n	%
No	184	92
Yes	16	8

Refractive Error

The refractive error variable can be seen from the condition if students use glasses to correct refractive errors. Of the 200 students, 79 people (39.5%) had refractive errors.

Table 5. Frequency Distribution of Refractive Error

Refractive Error	n	%
Yes	79	39,5
No	121	60,5

Analysis of the Relation between Viewing Distance, Eye Breaks and Refractive Errors with Symptoms of Visual Fatigue

The results of the study can be seen in table 6. Students who experience complaints of visual fatigue are greater at an unsafe viewing distance (88.2%) than a safe viewing distance (83.3%). Based on the results of statistical tests obtained p-value = 0.530 (> 0.05). It shows that there is no relation between monitor distance and visual fatigue. Then, students who experience visual fatigue complaints are more in respondents who do not rest their eyes (88.6%) than respondents who rest their eyes (68.8%). The results of statistical tests, obtained p-value = 0.04 (≤ 0.05). It shows that there is a relationship between eye breaks and visual fatigue. And then, students who experience visual fatigue complaints are more in respondents who have refractive errors (89.9%) than those who do not have refractive errors (85.1%). Statistical test results obtained p-value = 0.446 (> 0.05). It shows that there is no relationship between refractive errors and complaints of visual fatigue.

Table 6. The Relation between Viewing Distance, Eye Breaks and Refractive Errors with Visual Fatigue

Variable	Category	Visual Fatigue				Total		p value
		Yes		No				
		n	%	n	%	n	%	
Viewing Distance	Unsafe	134	88.2	18	11.8	200	100	0.530
	Safety	40	83.3	8	16.7	200	100	
Eye Breaks	No	163	88.6	21	11.4	200	100	0.040
	Yes	11	68.8	5	31.3	200	100	
Refractive Errors	Yes	71	89.9	8	10.1	200	100	0.446
	No	103	85.1	18	14.9	200	100	

DISCUSSION

Visual Fatigue

Visual fatigue is a problem related to eyes and vision caused by prolonged use of computers, laptops, iPads, and mobile phones. when seeing far or near, eye irritation, dry eyes, difficulty focusing, back and neck pain, sensitivity to light, and double vision (Anshel, 2005). The most frequently used digital devices by students are laptops and mobile phones. The most common visual fatigue symptom experienced by respondents was a headache, 53.5% with occasional intensity and 36.5% often. The results of this study are supported by research conducted on students at the Engineering College of Bengaluru. It was found that the prevalence of CVS was 86.67%. Headache is the complaint most complained by respondents, namely 83.5% (Ranganatha and Jailkhani, 2019).

During the COVID-19 pandemic, the prevalence of eye fatigue in students was higher than in the general public. Eye fatigue occurs as a result of online learning, and it worsens eye health (Kaya, 2020). Increasing the duration of using digital devices can increase the risk of dry eyes. If the time spent is more than four hours, it will increase the risk (Mufti et al., 2019). There are three categories of duration of use of digital devices, namely light (less than two hours), moderate (two to four hours), and heavy (more than four hours) per day (Mathew et al., 2017). Increased use of digital devices can affect the tear film and ocular surface because of the frequency of blinking decreases during the use of digital devices. There is an increase in tear evaporation which can harm the condition of the eye's surface (Artime Rios et al., 2019).

Viewing Distance

Visibility is affected by screen size, character size, and the visual attention required to perform a task effectively. The Occupational Safety and Health Administration (OSHA) recommends a 45-60 cm computer viewing distance (Gowrisankaran and Sheedy, 2015). The monitor distance is categorized as a safe distance if the eye distance from the monitor is 46 – 61 cm and unsafe if the eye and monitor distance is < 46 cm and > 61 cm (Putri and Mulyono, 2018). Results of the study, 76% of students used digital devices with an unsafe distance from the monitor to their eyes, as many as 150 people (75%) with a distance of less than 46 cm and 2 people (1%) with a distance of more than 61 cm. The results of this study are supported by research conducted on undergraduate medical students, more students with eye-to-monitor distances that do not match as much as 56% (Noreen et al., 2021).

The eye's point of view can be seen at the eye's position against the top of the digital device screen. A good screen position is at eye level or lower than the eye. The recommended angle for using digital devices is 10°-20° downwards (Sugarindra and Allamsyah, 2017). When looking down, the ocular surface exposed is reduced, thereby reducing tear evaporation. If the viewing angle is greater towards the top, then users of digital devices will lift their heads, causing muscle tension in the neck and reducing the frequency of blinking and tear production (Darmaliputra and Dharmadi, 2019). The slight imbalance between the computer screen and its surroundings is also an essential factor to consider. Screens with dark backgrounds often require low levels of light. To reduce glare and reflections on a computer screen can use a screen filter, but filters are used as an adjunct, not a substitute for poor room lighting, must adjust Screen brightness and contrast to balance the lighting (Loh and Reddy, 2008).

Lighting for activities using a computer is 500 lux for the task area or on the work desk and 300 lux for the space around the work desk. The horizontally lighting on the work desk should not

exceed 500 lux because it can cause changes in contrast on the screen of digital devices. It becomes difficult for the eyes to see characters or images on the net. The light source coming from behind the digital device screen, such as light coming from the window, can be adjusted by changing the location of the digital device so that the light behind the digital device is not brighter than the light from the digital device screen. The next step is to use lamps whose lighting is diffuse to reduce reflections on surfaces that can cause glare (Osterhaus, Hemphala and Nylen, 2015).

Eye Breaks

In this study, 184 respondents (92%) did not take eye breaks, and only 16 respondents (8%) did eye breaks. Eye rest in this study breaks the eye by following the 20-20-20 rule. That is, after using a digital device for 20 minutes, it is better to take your eyes off the object by looking at a thing as far as twenty feet (6 meters) for 20 seconds. In a similar study conducted on students in China during the COVID-19 pandemic, 56% did not know and did not take eye breaks (Li et al., 2021). Other studies on computer operators also found that more workers did not take eye breaks, namely 82.5% (Firdani, 2020). Eye rest is essential when using digital devices to reduce eye strain by diverting eye focus from the screen to relax the eye muscles (Rahman and Sanip, 2011) .

Taking short but frequent breaks for 5-10 minutes is better than resting for a long time of 2-3 hours. Taking a break for 5-10 minutes from the computer is recommended to use digital devices that work for 1-2 hours continuously (Bali, Neeraj and Bali, 2014). Changes in blinking patterns when looking at digital screens lead to an increasing prevalence of dry eye. Several studies report that blinking rates are reduced during computer use. Blinking frequency is 22 times per minute when relaxing, ten times per minute when looking at a book, and seven times per minute when looking at a digital device screen. There is a decrease in the frequency of blinking when text size and contrast are reduced or task or work requests increase (Rosenfield and Mcoptom, 2016).

To reduce stress on the eyes and increase productivity, take a brisk walk around the workplace, change sights and stretch your muscles. Working without rest for more than 4 hours is associated with eye strain. To restore the eye's accommodative system, prevent eye spasms, and subtract visual fatigue be with a short rest from activity in front of digital devices (Loh and Reddy, 2008).

Refractive Errors

Refractive errors can be corrected using glasses, but poor correction can be one of the risks of eye fatigue in digital device users. Users of digital devices who use glasses usually complain of headaches in the frontal area (Alma and Asniar, 2019). Activities that use digital devices require intense visual training, which can cause eye symptoms, especially for those who wear glasses. Correction errors in eyeglass users can cause eye fatigue because using digital devices is a type of close work on a screen that sees letters formed by small dots. It causes working harder to keep the image in focus on eyes that already have some problems (Rahman and Sanip, 2011).

In uncorrected refractive errors, the perceived blur is often continuous. However, if the perceived blur is intermittent, the accommodative disturbance may be the underlying cause. In addition, sub-optimal text quality and poor contrast and resolution can result in blurred perception for users (Gowrisankaran and Sheedy, 2015). The frequency distribution of respondents with refractive errors in this study was 79 people (39.5%). This study is in line with research that showed that 39% of students in Manado had refractive errors (Sumakul, Marunduh and Doda, 2020).

Relations Viewing Distance with Visual Fatigue

Analysis of the relationship between viewing distance and visual fatigue complaints shows no relationship between viewing distance and visual fatigue. The results of this analysis are in line with research conducted by Putri and Mulyono (2018) which also states that there is not only a relationship between viewing distance and visual fatigue. The cause of the absence of this relationship may be due to other factors such as the increased duration of use of digital devices so that most respondents experience eye fatigue. Digital device screens are placed at an ideal distance of 60 cm for a computer or laptop and 30 cm for smartphones (Bali, Neeraj and Bali, 2014).

In contrast to the results of research conducted by Tawil et al. (2018) on medical and business students at King Saud University, it found that there was a significant relationship between computer use at close range (<40 cm) with eye complaints and the highest prevalence in medical students. In addition to the viewing distance, prolonged use of gadgets will cause increased stress on the eyes, which is higher than working without using digital devices. It occurs due to excessive accommodation and convergence activity in the eyes when using digital devices. Excessive accommodation and convergence of the eyes due to the adjustment of the distance between the eyes and the digital device screen and the characters and images displayed on the digital device screen.(Permana, Koesyanto and Mardiana, 2015)

Visual fatigue can also occur when the eyes are focused on objects for a long time with the distance to the eyes closed so that the eye muscles have to work harder to see objects that move at very close distances. Bright lighting can increase the likelihood of eye fatigue. This condition causes the eyes to adapt by accommodating for a long time, resulting in a decrease in the accommodation power of the eye. Prevention efforts to reduce complaints of eye fatigue are by paying attention to the distance between the eyes and the monitor screen (Putri and Mulyono, 2018). In addition, the contrast on the monitor screen that is not right will increase the chances of fatigue complaints in users. Another effort to reduce eye fatigue is by placing the monitor screen in places that do not cause light from other sources, such as light from windows or lamps that can dazzle the eyes. The increase in the use of digital devices in the future will impact the eyes if users are not aware of it. Suppose users of digital devices are aware of and use digital devices safely and prioritize eye health. It will save users of laptops and other gadgets from wearing glasses.

Relations Eye Breaks with Visual Fatigue

Based on the study results, it was found that there was a relation between eye breaks and visual fatigue complaints in students with a p-value of 0.04. Similar to research conducted on employees of the Port health office in Medan, it was found that there was a significant effect of applying eye rest to the incidence of computer vision syndrome with a p-value of 0.001 (Anggrainy, Lubis and Ashar, 2020). Supported by research by Alghamdi and Alrasheed (2020), eye rest by doing a 20-second rest scheme every 20 minutes by looking at objects at a distance of 20 feet or 6 meters has been shown to reduce symptoms of eye fatigue and the impact of excessive use of gadgets . Taking breaks when using digital devices tends to relax the accommodating system. eyes that experience pressure from doing close work, thereby reducing eye fatigue and headaches (Akinbinu and Mashalla, 2014).

The Occupational Safety and Health Administration (OSHA) recommends that users of digital devices take at least 10 minutes of rest every hour or 15 minutes after working with digital

devices continuously. Eye rest is essential because eye fatigue complaints can arise due to reduced tear flow caused by significant reflections or glare on digital device screens. When staring at a computer screen, the frequency of blinking will decrease from its normal state so that the eyes become dry and irritated (Arianti, 2017). Taking eye breaks can reduce the impact of exposure to blue light produced by digital screens. Research shows that exposure to blue light on digital device screens poses minimal risk, but this has only been tested on short-term exposures, and it is not yet known for the risks associated with long-term exposure. Blue light with a short wavelength does not focus on the center of the retina, but in front of the retina, so prolonged exposure to blue light can cause eye fatigue and nearsightedness with symptoms of double vision so that it can cause inability to concentrate and affect work productivity (Zhao et al., 2018)

Relations Refractive Errors with Visual Fatigue

Based on the study results, it was found that there was no relationship between refractive errors and complaints of visual fatigue in students. In contrast to research conducted on PSSKPD students class 2017-2018 Udayana University, there is a relationship between refractive errors and complaints of eye fatigue with p-value 0.033 (Munif, Yuliana and Wardana, 2020). The cause of the absence of this relationship may be due to other factors such as the increased duration of use of digital devices so that most respondents experience eye fatigue. Refractive error is a disorder of refraction of light in the eye so that light is not focused on the retina but in front or behind the retina and may not be at a single focal point. People with myopia have a punctum remotum (far point) that is close so that the eyes are always in a state of convergence, causing eye fatigue. Refractive errors in myopia, hypermetropia, astigmatism can cause eye fatigue because they continuously accommodate to see the subject more clearly (Prayoga, 2014). Visual fatigue is felt more quickly in people who have refractive errors. Even if the person already uses glasses or contact lenses, visual fatigue can still occur because the eyes rarely blink when focusing on the monitor screen, causing the eyeball to dry quickly, causing friction between the lens and the eyelid contact (Munif, Yuliana and Wardana, 2020).

CONCLUSION

There is a relationship between eye breaks and visual fatigue, and there is no relationship between viewing distance and refractive error with visual fatigue. Recommended taking eye breaks by applying the 20-20-20 rule, which is to rest the eyes every 20 minutes by turning your eyes to look at objects twenty feet away for twenty seconds when using gadgets to reduce the risk of eye fatigue, and use gadgets with an ideal distance of 60 cm for computer or laptop use and 30 cm for smartphone use.

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